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COMMUNICATIONS

THE REGIONAL VARIATIONS OF EXTRAFOVEAL PERCEPTION OF FORM IN THE CENTRAL VISUAL FIELDS (PHOTOPIC VISION)*

WITH SPECIAL REFERENCE TO LESIONS
OF THE VISUAL PATHWAYS

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Introduction

Visual perception of form has, in the past, gained considerable attention from experimental physiologists and psychologists, the former investigating retinal and neural mechanisms, and the latter exploring the complexities of central perceptual processes. In the present investigation the problem of extrafoveal perception of form has been approached from the clinical point of view. An attempt has been made to evolve a clinical method of examining this aspect of visual function and in doing so the

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investigation has been directed mainly towards establishing the accuracy of the test and its value in clinical practice.

The factors influencing the perception of form have been summarized by Duke-Elder (1938) as follows :

- (1) State of adaptation of the eye.
- (2) Size of the pupil.
- (3) Region of the retina stimulated.
- (4) Influence of irradiation.
- (5) Intensity of illumination.
- (6) Spectral nature of light.
- (7) Distribution of light.
- (8) Condition of illumination of the surrounding field.

The present investigation is concerned only with the regional variations of extrafoveal form perception with the eye in a state of light adaptation while the other factors are kept as constant as possible. The term " perception of form " may be given two meanings. It may be defined as the perception of the form of the visual field or as the perception of the shape of the object-stimulus. The latter definition is the one which will be used here.

Wertheim (1894) is generally credited with the first investigation of extrafoveal form perception although he himself pays tribute to previous workers in this field. From his studies of the regional variations of form perception he constructed a graph which is still reproduced in modern text-books on visual function. Wertheim clearly recognized the variations in extrafoveal perception which exist between individuals, the variations in results which may be produced by different methods of testing form perception, and the influence on the results of practice in the tests by the subject. Rivers (1900), summarizing the information which had then accumulated, stated that acuity is most intense in direct vision and drops rapidly at first and then more slowly towards the periphery, and also that the difference between central and peripheral vision in respect of visual acuity is far greater than for other kinds of retinal sensibility. He attributed to Dobrowolsky and Gaine (1876) the discovery that the low degree of acuity at the periphery can be greatly improved by practice, thus differing in this respect from the sensibility for light and colour. Evans (1929) and Ludvigh (1941) both measured extrafoveal form perception, as did Wertheim's predecessors, by using Snellen type. This, however, does not allow vision to be examined beyond 10° of the fixation point and the method is therefore of limited value. Akelaitis (1942), in studying the effects of section of the corpus callosum, measured extrafoveal form perception with the shapes used in the Stanford-Binet intelligence test and also with common objects such as a pipe, comb, pencil, and pair of scissors. He described three cases in

which there was impairment of form perception although the fields of light perception were full. Low (1943) made the first adequate investigation of the problem of the regional variations of form perception by using a method employing Landolt's broken circles. From a study of a hundred normal subjects he concluded that 'extrafoveal perception of form is extremely variable between one subject and another, that it is not closely related to macular vision, and that it is a function capable of training. He noted, too, that beyond 30° of the fixation point the lens ceases to act efficiently.

This review of the literature shows that little work has been done on the regional variations of form perception in the presence of lesions of the visual pathways. This has probably been due to the difficulty that has been found in establishing the range of normality and of devising a test suited to the mental status of the average hospital patient. Because of their complexity, the methods of Low and of others investigating the general problem of form perception demand a type of co-operation rarely to be expected from a patient suffering from intracranial disease. Moreover it is a little difficult to correlate the results of such methods with the findings of clinical perimetry, a condition which it is necessary to fulfil in a study of lesions of the visual pathways.

In the present investigation a method was evolved which allows the results to be charted in a manner comparable to the visual field chart used in clinical perimetry. The investigation was further simplified by limiting the study to the central visual fields (30°) where the limits of normality are more easily defined than in the peripheral fields. Finally the value of the method was assessed by correlating the results with other clinical, radiological, and pathological studies of the patients chosen for investigation.

Apparatus

Five test-targets were used. Each consisted of a black card $2\frac{1}{2}$ inches square supported by a black wire about 1 foot long (Fig. 1). On one side of each card a square was constructed with strips of white paper $\frac{1}{8}$ inch wide, except in the case of the smallest square in which the strips were $\frac{1}{16}$ inch wide. The sizes of the squares (2, $1\frac{1}{2}$, $\frac{3}{4}$, $\frac{1}{2}$ and $\frac{1}{4}$ inches respectively) were determined by trial and error. The final choice was such that in a subject with good vision the squares could be identified at 5° intervals from the centre of the screen. Since examination beyond 25° was not attempted five targets were sufficient to cover all points on the screen.

On the reverse side of each card four strips of white paper were fixed in an irregular fashion to form what will henceforth be called a "jumble". The total area of white paper used for each jumble was equal to that used for the square on the obverse side of the card, and the four strips of the jumble were distributed over an area approximately equal to that covered by the square.

Procedure

The examination of the visual fields was made in a dark room on a 2-metre Bjerrum screen illuminated by two electric lamps. The patient, who always

entered the room from daylight or from a fully lighted room, was seated at a distance of 2 metres from the screen with his head supported in a chin rest so that his eyes were at the same level as the centre of the screen.

The fields of light and colour perception of the right eye were first plotted on the screen, unless vision in that eye was much less than in the left. Extrafoveal perception of form was then examined in the same eye. The left eye was treated in a similar way and finally the peripheral fields were charted on a perimeter. The resting eye was covered by an eye-shade. Macular vision was measured with Snellen and Jaeger type.

In testing the perception of form, the two sides of Target 1 were first demonstrated to the patient, who was then told that, while keeping his eye fixed on the centre of the screen, he was to name the side of the target being presented to him at various points on the screen. He was asked to state his first impression of the target and not to wait and think about it. If he found it difficult to make up his mind in a moment or so, he was to state simply that he did not know which side of the target was being shown to him.

The targets were held against the screen at a series of points lying on the radii 45° , 135° , 225° and 315° from the vertical. These points, A, B, C, D and E (Chart A, Fig. 2), were spaced at 5° intervals, A being midway between the marks on the screen indicating 20° and 25° .

Beginning with Target 1, the five targets were used in descending order of size. Each was used in turn, being first held at the point where the previous target had been correctly identified, and then moved in towards the centre until correct answers were given. Each was used in all quadrants before passing on to the next target. No fixed rules governed the number of times the target was shown at each point

FIG. 1.—The five test-targets, No. 1 at the top ($\times \frac{1}{2}$).

or the sequence of squares and jumbles. Generally the patient recognized the square or was unable to express an opinion, so that it was sufficient to show the

FIG. 2.—Chart A, showing standard tests.

square once or twice at each point, the jumble being reserved for occasional checks on his answers. A jumble was rarely recognized as a jumble, and when it was named correctly the square was always recognized at the same point. Some patients were reluctant to admit that they did not know which side of the target was being shown, and in these cases it was necessary to expose the target three or four times at each point so that the significance of their answers could be estimated.

The four most peripheral points at which each target was identified were marked on a chart and a line joining them formed an isopter of form perception. In cases with field defects, the targets were exhibited at points on the screen other than those mentioned. This was done at the discretion of the examiner so that defects could be more accurately outlined.

In cases where there was no measurable defect of form perception the patient was asked to give an opinion of the comparative clearness or definition of a square held at corresponding points in two quadrants or at two points lying on the same radius. His answers were not recorded unless they were consistent with

each target used, that is to say, the right or left was always thought to be the better side.

The lamps illuminating the screen were set so that in a subject with good vision the perception of form was equal in all quadrants. With the lighting used, a 2 mm. white target was seen by normal subjects at 20° to 30°, and 20° was found by experience to be the lower limit of normality even in the absence of refractive errors.

The pupils were examined in ordinary daylight and their size was not recorded unless they were very large or very small. No attempt was made to correct refractive errors as a routine procedure but advantage was taken of spectacles brought to hospital by the patients.

Material

Fifty hospital patients and thirteen normal subjects were studied. The patients form a highly selected group, for an attempt was made to include within the small compass of the series as many different types of lesions of the visual pathways as possible.

The patients were chosen according to the following criteria:

- (a) They were fully co-operative in the examination, although formal psychological testing revealed some mental retardation in a few cases.
- (b) They were all up-patients and were able to walk to the perimeter room.
- (c) They were all cases in which perimetry was part of the routine investigation, and were, for the most part, cases in which field defects were reasonably suspected or were known to be present.
- (d) They were all cases which either had no severe refractive errors, or had spectacles to correct such errors.

Results

The individual variation in extrafoveal form perception is considerable. Unfortunately the limitation of space prevents the reproduction of many charts, and to overcome this difficulty a classification has been adopted which will be used in describing cases. This classification (see Chart A, Fig. 2) depends on the position of one or two isopters as follows:

- (a) Fields of form perception (FFP) less than average ($<$ average).
Isopter to Target 2 lying within 15° to 20°.
- (b) FFP average (average).
Isopter to Target 2 lying at 15° to 20° or at 20° to 25°, while isopter to Target 4 lies within 15° to 20°.
- (c) FFP slightly better than average ($>$ average).
Isopter to Target 4 lying at 15° to 20° or at 20° to 25°, while isopter to Target 5 lies within 15° to 20°.
- (d) FFP much better than average ($>>$ average).
Isopter to Target 5 lying at 15° to 20° or at 20° to 25°.

These categories will be employed regardless of the position of other isopters.

(A) Cases without Refractive Errors and without Defects in the Fields of Light and Form Perception.—This group comprises nine patients with normal vision and eight normal subjects. In all of these macular vision (MV) was Snellen 6/9 or better and FFP was average or better. The results are summarized in the Table (P1-9 and S1-8). None of the patients was shown by special investi-

TABLE

Correlation of the Size of the Fields of Form Perception with Macular Vision and Occupation.

Cases with Uncorrected Vision

No.	Occupation	MV R/L	FFP R/L	No.	Occupation	MV R/L	FFP R/L
S1	Secretary ...	4/4	A/A	P25	Aero engineer ...	6/5	A/A
S2	Nurse ...	6/9	>A/>A	P26	Organist ...	6/9	A/A
S3	Housewife ...	6/6	A/>A	P30	Baker ...	-/5	-/A
S4	Typist ...	6/6	A/A	P31	Engineer-fitter ...	12/5	A/A
S5	Porter ...	5/5	A/A	P40	Presskeeper ...	No PL/9	-/>A
S6	Secretary (drives car)	5/5	>>A/>>A	P41	Housewife ...	5/-	>>A/-
S7	Nurse ...	5/5	>A/>A	P43	Housewife ...	9/9	A/A
S8	Foundryman ...	6/6	>>A/>>A	P49	Housewife ...	9/9	A/A
P1	Housewife ...	6/5	A/A	P50	Refrigeration engineer	6/9	A/A
P2	Schoolboy ...	5/5	A/A	S13	Porter ...	9/12	A/A
P3	Schoolboy ...	9/6	A/A	P10	Dressmaker ...	12/6	A/A
P4	Soldier ...	6/6	A/>A	P11	Ticket collector	18/18	>A/>A
P5	Housewife ...	6/9	A/A	P13	Innkeeper ...	24/12	A/A
P6	Labourer ...	6/6	A/A	P19	Cinema operator	-/12	-/A
P7	Baker ...	9/9	>A/>A	P21	Clerk ...	60/60	A/A
P8	Housewife (drives car)	6/6	>>A/>>A	P23	Compositor ...	9/18	>A/>A
P9	Electrical engineer	6/6	>>A/>>A	P27	Waiter ...	36/18	A/A
P22	Saleswoman ...	6/-	A/-	P28	Lorry driver ...	12/24	>>A/>A
				P45	Petty-officer ...	9/12	A/A
				P48	Foundryman ...	6/9	>>A/>>

Cases with Corrected Vision

No.	Occupation	Uncorrected Vision		Corrected Vision	
		MV	FFP	MV	FFP
S9	Physician ...	1/60 - 1/60	<A/<A	9/18	A/A
S10	Porter ...	1/24 - 1/24	<A/A	24/24	A/A
S11	Physician ...	1/18 - 1/24	<A/A	5/9	A/A
S12	Physician (drives car)	36/60	>A/>A	5/6	>>A/>>A
P12	Warehouseman ...	- - 1/18	-/A	-/18	-/A
P14	Housewife...	24/24	A/A	9/12	A/A
P15	Warehouseman ...	1/60 - 1/24	<A/<A	9/18	A/A

P = patients; S = normal subjects. No case drives a car unless specified.

Macular vision (MV) is measured with Snellen type at 6 metres. The two terms Right (R) 6/12 and Left (L) 6/9 are given as 12/9. At distances less than 6 metres the terms are given in full.

The size of the fields (FFP) is given in terms of "average" (A) already defined. Patients are quoted only when they have presumably normal eye-fields or normal half-fields, and the fields are described in terms of these normal parts of the visual fields.

gations to have lesions of the visual pathways. In plotting the fields of light perception (FLP) the smallest target used was a white 1 mm.

Four subjects who were examined are not included in this group. These were physicians who, in their determined efforts to prevent their eyes from moving, stared fixedly at the centre of the screen and had little attention for the targets. In each case the FFP was grossly contracted. In addition their attention for the targets seemed to fluctuate and their answers were inconsistent. This difficulty did not arise in other cases whose answers were consistent throughout.

A study of this group of cases shows the great variation in extrafoveal form perception, although this tends to be masked by using a classification consisting of only four categories. The limits of normality, in terms of the size of the fields, are difficult to determine, for the upper limit is imposed by the method itself since Target 5 may be identified at 20° to 25° and the lower limit seems to depend on the subject's ability to fix his eye on the centre of the screen while allowing his attention to wander to the periphery. Nevertheless the variations in the size of the fields are not altogether a matter of chance, for it is possible to correlate them, to some extent, with the occupations of the subjects as shown in the Table.

In the absence of refractive errors and lesions of the visual pathways the perception of form is equal in all quadrants of the fields although an occasional isopter may show a localized contraction (Chart 1*, Fig. 3).

In all the cases in this group there is a fairly close similarity in the size of the FFP in the two eyes. Further cases show this to be true, provided there are no refractive errors or lesions of the visual pathways causing asymmetrical distortion of the fields.

When given an opportunity to compare the definition of a square on the right and left sides (or upper and lower quadrants) of the fields, all cases admitted that vision seemed to be equally good on both sides. With a square held at the centre and more peripherally each individual was acutely aware that the square was most clearly defined at the centre and that this definition became progressively impaired as the square was moved to the periphery until ultimately it could not be distinguished from the jumble.

It was found that vision did not readily fatigue while form perception was being tested and that changes in the fields could not easily be produced by continuous testing over about 10

* The charts are numbered according to the patients to whom they belong.

Chart 1.

Chart 14.

Chart 18.

Chart 24.

Chart 29.

Chart 31.

FIG. 3.

minutes. It should be noticed that vision was momentarily rested between each exposure of the target.

Six cases were re-examined at intervals of 2 to 14 days and it was found that, although there were minor variations, the size of the fields on the basis of the present classification remained constant.

(B) Cases with Refractive Errors and without Defects in the FLP and FFP which can be attributed to Lesions of the Visual Pathways.—

This group comprises six patients and five normal subjects. The results are summarized in the Table (P 10-15 and S 9-13). In these cases refractive errors are judged on the fact that MV falls below Snellen 6/9.

As in the first group it can be seen that better than average form perception is related to occupation. Patients 13, 14, and 15 showed considerable irregularity of the isopters, and these irregularities changed but did not disappear with correction of the refractive errors. The refractive errors were not studied and the irregularity of the isopters may have been due to astigmatism. The patterns of the FFP, as shown in Chart 14 (Fig. 3) do not suggest field defects which can be attributed to lesions of the visual pathways.

The cases in this group are too few to attempt a detailed correlation between refractive errors and the FFP but the impression is gained that the lesser degrees of refractive errors which do not reduce MV below 6/24 have no influence on the size of the fields. This impression is strengthened by the fact that correction in such cases does not enlarge the fields. The more severe degrees of refractive errors seem to have a variable effect, and when the fields are reduced in size correction of the refractive errors may allow the fields to assume "average" proportions.

(C) Cases with Distortion of the Visual Fields other than those produced by Refractive Errors.—This group comprises 34 cases which, by means of various investigations, were shown to have lesions within the cranium*.

In this group it is necessary to attempt a correlation of the FLP and the FFP. This correlation is made in respect of the pattern and size of the fields. The pattern of the fields is assessed by considering the grouping of all the isopters making up each type of field, and attention is given to the shape as opposed to the size of the fields. The size of the fields is measured in terms of the isopters of the 2 mm. white target and Target 2, the size being measured with corrected vision when refractive errors cause contraction of the fields. The FFP and FLP are considered equal if the two isopters fall within 5° of each other.

*In all cases of neoplasm in Group C the lesions were verified by biopsy or at operation except in Cases 20, 22, and 48.

Chart 41. Left eye,

Chart 44.

FIG. 4.

1. *Cases in which the FLP and FFP are Similar in Pattern and Equal in Size.*—The diagnoses in this group were as follows :

- Case 16. Post-concussional syndrome with functional contraction of the fields.
- Case 17. Tabes dorsalis with optic atrophy.
- Case 18. Optic atrophy due to severe gastric haemorrhage.
- Case 19. Optic atrophy secondary to papilloedema caused by 3rd-ventricle colloid cyst.
- Case 20. Unconfirmed parasellar tumour with hemianopia.
- Cases 21 and 22. Pituitary chromophobe adenoma.
- Case 23. Craniopharyngioma.
- Case 24. Tobacco amblyopia.
- Cases 25 and 26. Thrombosis of posterior cerebral artery.
- Case 27. Temporal lobe meningioma.
- Case 28. Unconfirmed thrombosis of brain stem vessel.
- Case 29. Senile exudative choroidoretinitis.

In all cases in this group vision was either stationary, or deterioration was only slowly progressive over several months. In the charts the isopters of light perception are marked in continuous lines and the isopters of form perception in interrupted lines. Similarly, light perception scotomata are enclosed in continuous lines and form perception scotomata in interrupted lines and cross-hatched. The size of the target in millimetres or its number is placed against each isopter. The charts represent examination on the Bjerrum screen.

Patient 18 (Chart 18, Fig. 3). Female, aged 54 years. Kitchen hand. Loss of sight followed a severe haematemesis 33 years before present admission. Vision of right eye recovered completely, according to patient, and left eye remained blind. Bilateral optic atrophy. MV: L, No PL; R, 6/18 uncorrected, 6/9 with spectacles. FLP and FFP—irregular contraction.

Patient 24 (Chart 24, Fig. 3). Male, aged 55 years. Clerk. Tobacco amblyopia. Progressive failure of vision for 5 months but no change in recent weeks. No change in the fields after 3 months. MV: L, 2/36. R, 6/18 uncorrected. FLP and FFP—centrocaecal scotomata.

Patient 28. Male, aged 48 years. Lorry driver. Unconfirmed thrombosis of brain stem vessel. Left eye always lazy but no history of squint. Disks normal. MV: L, 6/24; R, 6/12 uncorrected. FLP—a 2° central scotoma in left eye-field. FFP—subjectively Target 5 more clearly defined at 5° than at centre. Otherwise right eye-field >> average, left eye-field > average.

Patient 29 (Chart 29, Fig. 3). Male, aged 70 years. Retired storekeeper. Bilateral degenerative condition of retina and choroid with exudate at macula. Progressive failure of vision for 2 years with little change in few months prior to admission according to patient. The patient was able to see furniture in room but could not identify smaller objects. He was able to get about the streets without difficulty. MV: R and L 1/60, J20. FLP and FFP—a 15° central scotoma with the 2 mm. target and Target 2. The difficulty in fixation prevents a close correlation between the size of the fields.

2. *Cases in which the FLP and the FFP are Similar in Pattern but Unequal in Size.*—The diagnoses in this group were as follows :

- Case 30. Recurrent mania. This patient had a latent strabismus and a central scotoma as in Case 28.
- Case 31. Sphenoidal ridge meningioma.
- Case 32. Leber's optic atrophy.
- Case 33. Suprasellar meningioma.
- Cases 34 and 37. Parietal glioma.

- Case 35. Parietal meningioma.
- Case 36. Temporo-parietal glioma.
- Case 38. Meningioma over lower end of Sylvian fissure causing severe papilloedema.
- Cases 39 and 42. Aneurysm in region of optic chiasma.
- Case 40. Dermoid cyst of pituitary fossa.
- Case 41. Syphilitic neuro-retinitis.

In some of the cases of this group vision was deteriorating rapidly or improving rapidly either as the result of treatment or spontaneously as in the case of the aneurysms. In all others there was mental retardation (see Summary of Results). Case 32 was an exception in that vision was stationary, but here the isopter to the 2 mm. target was so reduced that a correlation of the FLP and FFP was impossible. The case is included here, however, for convenience.

Patient 31 (Chart 31, Fig. 3). Male, aged 41 years. Engineer fitter. Sphenoidal ridge meningioma. Progressive loss of vision in right eye for 1 year becoming more rapid recently. MV: L, 6/5; R, 6/12. Central vision in right eye fluctuated during the examination. The left eye-field was full and average.

Patient 32 (Chart 32, Fig. 4). Male, aged 33 years. Coach finisher. Leber's optic atrophy. Loss of vision in L eye for 11 months and in R eye for 8 months. Vision amounted only to discrimination between light and shade. None of the targets of form perception were identified.

Patient 41 (Chart 41, Fig. 4). Female, aged 29 years. Housewife with two young children. Works in a factory, packing cakes in boxes. Syphilitic neuro-retinitis. FLP and FFP in left eye-field—Chart B was taken 2 weeks after Chart A, penicillin having been given during the interval. Chart B shows that, while vision was improving, the isopter to Target 2 was greater (5°) than the isopter to the 2 mm. target. In the R eye-field there was a diminution of form perception in the R lower quadrant although the FLP was full. At the time of Chart B this defect had disappeared and the whole field had improved from average to >> average.

3. Cases in which the FLP and the FFP are Dissimilar in Pattern.

(i) *Cases with distorted FLP.*—The diagnoses in this group were as follows:

- Case 43. Frontal meningioma.
- Case 44. Neoplasm in relation to optic nerve.
- Case 45. Glioma of temporal lobe with marked papilloedema. In this there was a hemianopia in the FFP while the FLP were concentrically contracted. A hemianopia in the FLP developed after a needle biopsy.

Patient 44 (Chart 44, Fig. 4). Male, aged 45 years. Engineer fitter. At operation a small neoplasm was found under the left optic nerve immediately anterior to the chiasma. No attempt was made to remove the tumour or define its boundaries in relation to the chiasma or tracts. Progressive failure of vision for 6 months. A follow-up of this case showed that the progressive failure of vision was more apparent in the FFP than in the FLP. In the charts the right lower quadrant defect is homonymous while the centrocaecal scotoma was found only in the left eye.

(ii) *Cases with Full FLP.*—The diagnoses in this group were as follows:

- Case 46. Parietal glioma.
- Case 47. Temporo-parietal glioma.
- Case 48. Fronto-parietal glioma.
- Case 49. Meningioma in floor of middle fossa.
- Case 50. Naso-pharyngeal epithelioma.

In all the cases in this group the fields of colour perception were full on the screen (except 46, in which colour perception was not examined), and the fields of light perception were full to a 1 mm. and 2 mm. target on the screen and to a 1.5 mm. target on the perimeter.

Patient 49 (Chart 49, Fig. 4). Female, aged 38 years. Housewife. At operation a meningioma in the floor of the left middle fossa. Disks normal. MV: R and L, 6/9 uncorrected. FFP—incongruous right homonymous hemianopia. A dense right hemianopia in the FLP followed operation.

Summary of Results found in Group C*.—The numbers of all the cases are given in order to show the proportion presenting each type of result. The numbers of cases are given in bold type when they have previously been given as examples.

Cases 16 to 42 (**18, 24, 28, 29, 31, 41**) show that the FLP and the FFP have essentially a similar pattern.

Cases 38, 42, 43 and 44 show that a complex defect in FLP may be clarified in the FFP.

Cases 16 to 29 (examples as above) show that when vision is stationary or only slowly changing the FLP and the FFP are equal in size (within 5°).

Cases 31, 33, 41, 42, 44 show that when vision is rapidly deteriorating the FFP is smaller ($5^\circ +$) than the FLP in the affected parts of the fields.

Cases 30, 34, 36, 37, 46 show that when there is mental retardation the FFP is smaller than the FLP over the entire field.

Cases 38 and 45 show that when the fields are contracted due to papilloedema the FFP is larger ($5^\circ +$) than the FLP.

Cases 39, 40, and 41 show that when the fields are rapidly expanding the FFP is larger than the FLP.

Case 29 shows that the ability to identify target 2 over a fairly wide area of the central fields, although a central scotoma is present, may be a measure of the usefulness of vision in respect of getting about the streets.

Case 32 shows that an inability to identify target 2 anywhere in the central fields, although the 2 mm. target can be seen, may be associated with vision which for practical purposes is reduced to discrimination between light and shade, that is, to virtual blindness.

Cases 45 to 50 (**49**) show that a defect in the FFP may be present while the FLP and colour perception are full.

Case 28 shows that the depression of central vision, which is probably the result of latent strabismus, is apparent to the patient in the test of form perception. The FFP may otherwise be greater than average.

*Note: Case 17 was the only one in which the size of the pupils was abnormal.

Discussion

The variability of extrafoveal perception of form described by Wertheim (1894), Low (1943), and others has been substantiated by the present investigation. It became evident, however, that these variations are not altogether a matter of chance since it is possible, to a certain extent, to correlate the fields of form perception with occupation. That people with occupations requiring good peripheral vision should have better than average extrafoveal perception of form is to be expected, and proves in an indirect way the point made by Rivers (1900) and Low that extrafoveal form perception can be trained.

The lack of close correlation between refractive errors and extrafoveal form perception, which was demonstrated by Low, is also confirmed by the present investigation. Yet some relationship does exist and when severe refractive errors are present the fields of form perception are contracted. This contraction can be abolished by correction of the refractive errors. This improvement in the fields occurs coincidentally with the improvement in macular vision so that there is little to be gained in testing peripheral vision when spectacles are prescribed.

The present method allows the perception of form to be tested in individuals with central scotomata and in such cases may enable spectacles to be prescribed when severe refractive errors are present. Measurement of extrafoveal perception of form in such cases may be helpful also in the assessment of the usefulness of peripheral vision although to do this with accuracy a large number of cases will require to be studied.

The factors influencing the comparative sizes of the fields of light and form perception are of interest but at the moment seem of little practical value. Moreover since it is impossible to estimate the size of the fields before the onset of disease and since the size of the fields is so easily reduced by psychological factors it follows that the measurements of size cannot find a place as a clinical routine.

The comparison of the patterns of the fields of light and form perception is of more practical interest. By correlating the two types of fields, and also by correlating the fields of form perception with other clinical studies, it has been proved fairly conclusively that defects in the fields of form perception are a reliable guide to lesions of the visual pathways. Although they rarely give additional information when the fields of light perception are distorted, they may, in an appreciable number of cases, show defects before these become apparent in the fields of light and colour perception. This is possible since the fields

of form perception as charted by the present method lie mainly within the isopters of the 1 mm. and 2 mm. white targets which, when full, leave the greater part of the central fields uncharted. It is reasonable to suppose that, on the basis of the evolution of visual function, the perception of form would show impairment before that of light and that on the same basis the perception of colour would show impairment before either. That the latter is not the case can only be referred to the inaccuracy of colour perimetry.

There is no doubt that the test of form perception has several advantages over the tests of light and colour perception. The patient is spared the difficult task of dissociating the target from the rod supporting it, as in testing light perception with small targets; it is possible for the examiner to exclude guess-work on the part of the patient; there is no great tendency to fatigue as in colour testing; from the patient's point of view the test is easier than that of colour testing; and the test allows the patient to make a comparison of various parts of the fields, a procedure which brings the test into line with other forms of sensory testing.

The value of extrafoveal form perception testing would therefore seem to be threefold. It can reveal an early defect; it can confirm an equivocal defect in the fields of light and colour perception; and it tends to reduce a complicated defect in the fields of light perception to a simpler pattern. It is suggested therefore that the method be reserved for cases having fields of light perception which are full, equivocal, or bizarre. When the fields of light perception are full, the method of testing form perception need not be pursued if Target 2 reveals no defect; but should a defect be found it is important to remember that the other isopters must be charted, since refractive errors sometimes cause a distortion of only one isopter.

Summary

- (1) A method of testing extrafoveal perception of form is described.
- (2) The results of testing thirteen normal subjects and fifty patients are detailed.
- (3) The variability of extrafoveal form perception is demonstrated and a classification of variations suggested.
- (4) It is suggested that variations can be related to occupation.
- (5) The effect of refractive errors on the fields of form perception are described.
- (6) The comparative sizes of the fields of light and form perception are shown to be related to several factors.

(7) It is shown that a defect in form perception can be revealed before a defect in light or colour perception.

(8) It is proved that a distortion of the fields of form perception is a reliable indication of a lesion of the visual pathways.

(9) Other advantages of form perception testing are discussed.

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